The Kuh-e-Surmeh mineralization, a carbonate-hosted Zn-Pb deposit in the Simply Folded Belt of the Zagros Mountains, SW Iran

Abstract The Kuh-e-Surmeh carbonate-hosted zinc-lead deposit, located within the Simply Folded Belt of the Zagros Mountains in southwestern Iran, is an orogen-related Mississippi Valley type deposit originally formed in the foreland Thrust Belt of the Zagros Mountains. Structural and textural observations indicate that ore deposition took place as open-space fillings in brecciated carbonate rock and as internal sediments consisting of fine-grained ore minerals interlayered with carbonates. The preferred genetic model for the concentration of the ore metals is that of dewatering of the Zard-Kuh basin due to regional tectonic compaction tectonism and expulsion of basin-derived fluids into the highly porous and brecciated dolomitized rocks of the Dalan Formation. The metals precipitated from dense basinal brine (15 wt% equiv. NaCl) at low temperatures (less than 200 °C), typically within strata of a Late Paleozoic carbonate platform.

Introduction

This paper discusses the genesis of the Kuh-e-Surmeh carbonate-hosted zinc-lead deposit located within the Simply Folded Belt (Colman 1978) of the Zagros Mountains in southwest Iran (lat. 28.5°N and long. 52.5°E), about 240 km by road south of the city of Shiraz (Fig. 1). The deposit was discovered in 1972 and was partially mined by the Barite Company. Several years later, the limits of the orebody were confirmed by drilling and several companies then conducted various other investigations, including additional drilling, geochemical surveys and metallurgical tests, which in turn led to the development of more than 1300 m of underground workings. The mine district covers tens of square kilometres and exhibits many geophysical anomalies (Barytine Iran Company report 1982).

The Kuh-e-Surmeh orebody contains more than 990,000 tonnes of ore grading 12.1 wt% Zn and 5.4 wt% Pb. Before its closure in 1979, underground mining produced more than 150,000 tonnes of ore over a period of about 8 years. Many of the workings are now inaccessible due to accumulations of mud and numerous roof collapses.

The origin of the Kuh-e-Surmeh deposit has been a subject of lively and prolonged discussion since its discovery, and despite a number of studies, there is still considerable uncertainty regarding its genesis. Two principal hypotheses have been proposed, namely an epigenetic origin (e.g. Taghizadeh 1969; Solymani 1996) and a syngenetic origin (e.g. Nekisa and Amstutz 1976).

The present study concentrates on field and petrographic observations, emphasizing textures and structural features of the sulfide ore minerals and their associated carbonate host rocks. Microthermometric analyses of fluid inclusions in coexisting transparent gangue minerals and sphalerite are also included.

The geological setting of the area and the observed petrographic fabrics suggest a possible orogeny-related Mississippi Valley-Type (MVT) mineralization, as described below.

Geological setting

The Kuh-e-Surmeh Zn-Pb deposit is unique within the southern part of the Main Zagros Thrust Zone in the Firoozabad region (Fig. 1). Detailed descriptions of the geology of the Zagros Mountains are given by several authors (e.g. Kashfi 1976; Farhoudi 1978; Alavi 1980; Ghavidel-Syooki 1995). The present study considers many regional aspects of the Zagros Mountains, including sedimentation, stratigraphy, tectonic activity and structural evolution. The consensus is that convergence of the Arabian and Persian plates started in Early Mesozoic time, causing gradual closure of the Tethys oceanic basin and consequent subduction of the Arabian plate beneath the stable Persian plate. The Main
Zagros Thrust is thought to be a zone of Late Cretaceous collision between these two plates.

Widespread salt deposition of Upper Precambrian age occurred over a major portion of the present southern Zagros Mountains. The salt section is overlain by a laterally continuous sequence of Upper Precambrian to Triassic sedimentary rocks (Stocklin 1974). During Paleozoic time, sedimentary basins representing geosynclinal conditions in this area were part of the main Tethys geosynclinal system (Kashfi 1976). Sedimentation during the Permian was characteristic of a platform facies composed mainly of shallow-water carbonates. Carbonate sedimentation continued into the Late Cretaceous and was succeeded by chalk, marl and limestone of Eocene age (Kashfi 1976; Alavi 1980; Ghavidel-Syooki 1995).

According to Stocklin (1986), tectonic activity was negligible up to the Triassic. The earliest important deformation of the Zagros geosyncline took place in Late Cretaceous time and affected only the so-called High Zagros (Falcon 1974).

**Structure**

Folds in the form of a several parallel anticlines and synclines are the dominant structural features of the area. The overall strike of these folds is broadly NW-SE, parallel to the general regional trend of the Zagros Simply Folded Belt. The ore-bearing Paleozoic carbonate sequence is folded and mineralization occurs on both flanks of the Kuh-e-Surmeh Anticline (Fig. 2). This anticline, the major regional fold of the mine area, strikes northwest, with a steeper flank on the southern side. Although the anticline persists for several kilometres, the Jahani salt plug cuts it and diverts the anticlinal axis toward the north. Together with other salt plugs in the area, the diapirc salt caused a general uplift of overlying stratigraphic units.

Numerous faults cut the Kuh-e-Surmeh Anticline and have modified the general NE-SW structural trend of the orebody. A major thrust fault in the area coincides with the axial trace of a syncline lying to the south of and parallel to the Kuh-e-Surmeh Anticline (Fig. 2).

**Stratigraphy**

The Paleozoic rocks of southwest Iran are exposed mainly near the Main Zagros Thrust. Although only Ordovician and Permian sediments of the Paleozoic units crop out beyond the Main Zagros Thrust, the stratigraphic units are as follows:

- **Ordovician**: Aghajari Fm., Mishan Fm., Gachtsarman Fm.
- **Cambrian**: Asmari Fm., Pabdeh Fm., Gurgi Fm., Sarvak Fm.
- **Carboniferous**: Kazhduni Fm.
- **Permian**: Draiyani Fm., Fahlbian Fm., Surmeh Fm., Triassic Fms.
- **Triassic**: Paus Fm., Hormoz Fm. (Salt Plug)
- **Cretaceous**: Upper Cretaceous: Kt*, Dr*, Fa*, Sm, Tr, Fm, P, Sp
- **Eocene**: Gs
- **Oligocene**: Pd, Gu
- **Miocene**: As, Al, Mm
- **Pliocene**: Gs
- **Quaternary**: Al

**Fig. 1** Geographic map of Iran showing the location of the Kuh-e-Surmeh deposit and the major structural zones of the Zagros Mountains. **A-A’** represents the cross section shown in Fig. 8.

**Fig. 2** Simplified geologic map of the Kuh-Surmeh region.

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**STRATIGRAPHIC LEGEND**

**QUATERNARY:**
- Al: AlloviuM and Recent Deposits
  - Bakhtiyari Fm.

**OLIGOCENE:**
- Pd: Pabdeh Fm.
- Gu: Gurgi Fm.
- Gs: Gachsarman Fm.

**Eocene:**
- As: Asmari Fm.
- Pd: Pabdeh Fm.
- Gs: Gachsarman Fm.
- Dr: Draiyani Fm.

**Cretaceous:**
- Kt*: Kazhduni Fm.
- Dr*: Draiyani Fm.
- Fa*: Fahlbian Fm.

**Triassic:**
- Sm: Surmeh Fm.
- Tr: Triassic Fms.

**Paleozoic:**
- P: Paleozoic Fms.
- Sp: Hormoz Fm. (Salt Plug)

**Conventional Symbols**

- Anticlinal Axis
- Normal Fault
- Thrust Fault
- Synclinal Axis
- Pb-Zn Ores

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